III. *On the phylogenetic significance of the variations produced by difference of temperature in* Vanessa atalanta. *An Appendix to the preceding paper.*

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Mr. Merrifield has kindly invited me to express my opinion as to the bearing of the variations produced by differences of temperature in his specimens of *Vanessa atalanta* on the question of the race-history of the Vanessas. I am strongly disposed to think that further data are necessary before very much light can be thrown on the subject from this source; nevertheless, certain conclusions seem possible from the remarkable series so carefully reared by Mr. Merrifield under accurately recorded conditions of temperature, and perhaps a brief note on the subject may be not devoid of interest, even at the present stage of the enquiry.

For the purposes of this note, I divide Mr. Merrifield's specimens of *V. atalanta* that I have seen as follows:—

A. Reared from pupæ at a temperature of 80° to 90° F. 10 specimens. (Fig. 3).
B. Reared at ordinary temperatures. 10 specimens.
C. Reared from pupæ at about 54° to 56°. 10 specimens. (Fig. 4).
D. Reared from pupæ at 45°. 7 specimens. (Figs. 5 and 5*a*).

Both A and D exhibit features which appear to be ancestral, together with other features which would seem to be the direct result of temperature conditions, or at least to have no assignable phylogenetic import. Although both A and D show indications of reversion, the ancestral marks are different in the two cases. The specimens grouped as C do not differ very greatly from the normal, but are in most respects intermediate between B and D.

Ancestral marks produced at high temperatures (A).

(1). The presence of a scarlet patch on the under surface of the fore wing between the first median nervule and submedian nervure (in two specimens).

(2). The increased width of the scarlet band on the fore wing, and the tendency in some cases of its inner margin towards resolution.

(3). The somewhat diminished intensity of the scarlet of the fore wing.

(4). The suffusion of the dark portion of the wings with golden brown.

In all these respects the specimens of A approach *P. callirrhoë*, which is, in my view, an older and less specialised form than *V. atalanta* (Trans. Ent. Soc. Lond., 1890, p. 123, and note). The scarlet patch (1) is undoubtedly identical with a light-coloured area, between the spots distinguished as II. 8 and III. 8, which is met with on both surfaces of *P. callirrhoë*, and is present in a more ample form in other members of the group (ibid., Pl. III., figs. 33, 40, 41, representing *V. polychloros*, *A. levana*, and *P. carye* respectively).

Ancestral marks produced at low temperatures (C and D).

(1). The presence, in some specimens, of blue or lavender centres to the black submarginal spots of the hind wings.

(2). The presence, in two specimens, of minute groups of blue scales near the margin of the dark portion of the hind wing, indicating the centres of another series of spots (the series distinguished as III., well seen in *G. c-aureum* and *P. gonerilla*, ibid., Pl. II., fig. 25).

(3). The presence, in two specimens, of marginal blue on the hind wing.

With regard to (1), it is clear that the tendency is for the blue centring to increase as the temperature diminishes. Thus (to use the system of nomenclature proposed by the writer, *loc. cit.*) IV. 15 is, of course, universally blue-centred; IV. 14 is blue-centred in one of A, five of B, eight of C, and all of D; moreover, five of the seven specimens comprising the latter group have blue centres to other members of IV. as well. The remarkable specimen of D figured (fig. 5) has IV. 12 to

15 undoubtedly blue-centred in each hind wing. Reasons for considering this a character that belonged to the earliest members of the *Vanessa* group may be found in Trans. Ent. Soc. Lond., 1890, p. 97, *et seq.*

The marks referred to above under (2) are exceedingly minute, but still certainly visible in a fair light. They occur in only one of group D. In this insect the right side has III. 10 to 14, and perhaps 15, the left side III. 10 to 14, indicated by very minute patches of blue scales, somewhat like the rudimentary ocellus in *V. io*, but even smaller. One specimen of the intermediate group C has similar indications of III. 12 to 14.

The marginal blue (3) is in all probability an extension of the blue often seen on the marginal side of the large blue-centred spot IV. 15 in normal specimens of *V. atalanta*, and appears to represent that survival of the original bluish ground colour which is visible in *A. niphe* close to the margin, and especially at the anal angle of the hind wing, externally to those remains of the ground colour from which are developed the blue centres of IV. (ibid., p. 101).

To other characters seen in specimens of C and D, such as the remarkable alterations in the under side of the hind wing, and the suffusion of the fore wing with white and lavender scales, I am not able to assign any phylogenetic import.

A fair proportion of the effects of both heat and cold thus seem to point in the direction of reversion to an older form than the normal *V. atalanta*. But what is especially noticeable is—that in the first case (that of heat) the form approached is *P. callirrhoë*, a very near relative of *V. atalanta ;* while in the second case (that of cold) the approach is to a still more ancestral form, such, indeed, as may be supposed to be the common progenitor of *Vanessa*, *Pyrameis*, *Hypanartia*, and *Grapta*.

General Observations.

Is it possible that a disturbance of natural temperature conditions, whether in the direction of heat or cold, can produce in a monomorphic species a tendency towards reversion? Mr. Merrifield's experiments seem to go far towards answering this question in the affirmative. It need hardly be pointed out that Weismann's results with *A. levana* and *P. napi*, as also Edwards's with

P. ajax (all many-brooded species) are interpreted by the former author in a like sense. These results, however, are confined to the artificial production of the oldest of several still extant forms of the same polymorphic species; whereas Mr. Merrifield's experiments with a monomorphic and not very variable insect seem to have revived forms of the species older than any now extant.

The possibility that exposure to greater heat as well as cold may induce reversion is alleged by Weismann ('Studies in Theory of Descent,' ed. Meldola, 1882, vol. i., p. 37). But that features so revived should be entirely distinct in the two cases, although ancestral in both, is, so far as I am aware, a quite new and unexpected result.

It would seem that unless the whole alteration in these cases is the direct consequence of temperature conditions, which is unlikely, we must admit the possibility that a greater or less degree of atavism may be induced by disturbing conditions; the point to which the species "throws back" being controlled by the nature of the disturbance. Mr. Merrifield's experiments with the double-brooded *S. illustraria* (Trans. Ent. Soc. Lond., 1890, p. 131, &c.) appear to indicate that the case of this latter is not completely parallel with that of *A. levana*, inasmuch as the "summer" as well as the "winter" form is in *S. illustraria* capable of being artificially produced (though with difficulty), whereas in *A. levana*, as is well known, it is not possible to artificially produce the "summer" form. This fact with regard to *S. illustraria* may be due, as he suggests (ibid., p. 142), to the direct effect of temperature; or, as he has also pointed out to me, it may possibly indicate that the summer form of *S. illustraria* is itself a reversion to an ancestral condition. If this latter be the case, the supposed explanation of the different effects of heat and cold in the instance of *V. atalanta* would receive some confirmation, for we should then have another example in which the point to which reversion was directed could be to some extent controlled.

On the whole, therefore, it seems to me just conceivable that earlier forms which were developed under certain natural temperature-conditions may sometimes be under similar conditions independently restored.

Assuming this to be the case, we may perhaps explain the results arrived at by Mr. Merrifield with *V. atalanta* as follows :—

The warm "*callirrhoë*" stage is more recent than the cool "blue-centred" stage (see above, p. 71). The normal *V. atalanta*, though still more recent than the "*callirrhoë*" form, shows in some respects a kind of atavism, skipping the "*callirrhoë*" stage, and reverting in certain points (*e. g.*, the white spots on the fore wing, and the blue about the anal angle of the hind wing) to an earlier one. By the subjection of the pupæ to a sufficient amount of cold, the moderate atavism of the recent *V. atalanta* may be rendered more pronounced ; while the substitution of heat at the same time both checks the atavism and encourages reversion to a more immediate ancestor. In other words, the normal *V. atalanta* may be *warmed back* towards *P. callirrhoë*, or *cooled back* still further towards the "protovanessa."